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For: VEHICLE POWER CABLES RETAINING STRUCTURE

**CLAIM FOR PRIORITY**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

Date: September 27, 2004

Sir:

The benefit of the filing date of the following prior foreign application filed in the following foreign country is hereby requested for the above-identified patent application and the priority provided in 35 U.S.C. §119 is hereby claimed:

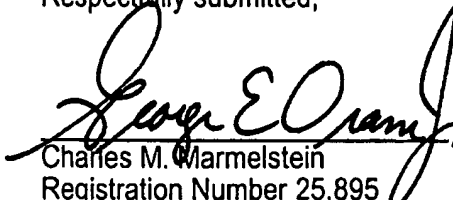
**Japanese Patent Application Number 2003-013525 filed on January 22, 2003**

In support of this claim, a certified copy of said original foreign application is filed herewith.

It is requested that the file of this application be marked to indicate that the requirements of 35 U.S.C. §119 have been fulfilled and that the Patent and Trademark Office kindly acknowledge receipt of this document.

Please charge any fee deficiency or credit any overpayment with respect to this paper to Deposit Account Number 01-2300.

Respectfully submitted,

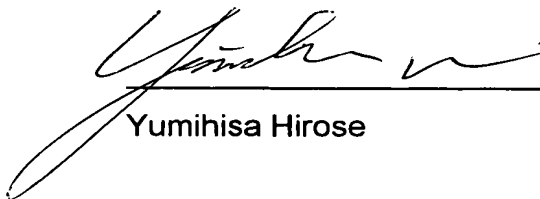
  
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Enclosure: Priority Document (1)



I, Yumihisa Hirose of Ark Mori Building, 13F, 12-32, Akasaka 1-chome, Minato-ku, Tokyo 107-6013, Japan, do hereby certify that I am conversant with the English and Japanese languages and am a competent translator thereof, and I further certify that to the best of my knowledge and belief the following is a true and correct translation made by me of the document in the Japanese language attached hereto.

Signed this 6th day of April, 2006

  
Yumihisa Hirose

Partial Translation of  
Japanese Patent Application No. 2003-013525

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[Article]	Specification	1 copy
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[Designation of Document]

Specification

[Title of the Invention]

VEHICLE POWER CABLES RETAINING STRUCTURE

5 [Claims]

[Claim 1] A vehicle power cables retaining structure for retaining power cables laid out along an underside of a floor of an electric vehicle, wherein

10 the power cables are individually passed through metallic protection pipes, and the metallic protection pipes are then retained on the underside of the floor of the vehicle.

[Claim 2] A vehicle power cables retaining structure for retaining power cables laid out along an underside of a floor of a hybrid vehicle which is driven to run by an engine and  
15 a motor, wherein

the power cables connect a power converter disposed outside an engine compartment with the motor disposed inside the engine compartment, wherein the power cables are individually passed through metallic protection pipes under  
20 the floor, and the metallic protection pipes are then supported from the underside of the floor, and wherein, in the engine compartment, the power cables are passed through a flexible protection tube.

[Claim 3] A vehicle power cables retaining structure as set  
25 forth in Claim 2, wherein the protection tube includes an iron

corrugated tube or an iron flexible tube having a net-like shield portion.

[Claim 4] A vehicle power cables retaining structure as set forth in Claim 1 or 2, wherein the protection pipe is formed  
5 by being bent after the power cable is passed therethrough.

[Claim 5] A vehicle power cables retaining structure as set forth in Claim 1 or 2, wherein the protection pipe is decreased in diameter by crimping an intermediate portion of the protection pipe along the length thereof.

10 [Claim 6] A vehicle power cables retaining structure as set forth in Claim 1 or 2, wherein the protection pipe is divided into a plurality of protection pipes, the plurality of protection pipes so divided being connected to each other by an iron corrugated tube or an iron flexible tube having a net-like  
15 shield.

[Claim 7] A vehicle power cables retaining structure as set forth in any of Claims 1 to 6, wherein a refrigerant is allowed to flow through a gap formed between the protection pipe and the power cable.

20 [Claim 8] A vehicle power cables retaining structure as set forth in Claim 7, wherein a fin is provided on at least either of an inner surface or an outer surface of the protection pipe in such a manner as to protrude therefrom.

[Claim 9] A vehicle power cables retaining structure as set  
25 forth in Claim 8, wherein the fin has a T-shaped cross section.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

The present invention relates to a vehicle power cables  
5 retaining structure.

[0002]

[Prior Art]

A power cable for supplying power from a battery to a  
driving motor in an electric vehicle has relatively thick in  
10 diameter and is hence relatively heavy in weight.

Due to this, conventionally, as is disclosed in Patent  
Literature No, 1, for example, a plurality of power cables are  
fixed onto a floor, and the power cables so fixed are then  
surrounded all together by a protection cover which is formed  
15 by bending a plate material.

[0003]

[Patent literature No. 1]

JP-A-5-207610

[0004]

20 [Problem that the Invention is to Solve]

However, in the event that the plurality of power cables  
are surrounded collectively by the protection cover in the  
conventional fashion, a large useless space is created within  
the protection cover, and this leaves a problem to be solved  
25 from a viewpoint of effective use of a space above the floor.

In addition, a route along which the power cables are laid out is not always simply linear but may become sometimes complex due to rises and bends, and in the event that the protection cover is attempted to be mounted along the power  
5 cables which are routed complexly, the protection cover itself has to be formed into a complex shape accordingly, and the formation of such a complexly shaped cover becomes difficult. Additionally, there occurs a case which requires the protection cover to be divided into a plurality of portions, and this makes  
10 troublesome the mounting of the protection cover so divided, the workability and productivity being thereby deteriorated.  
[0005]

Then, the invention is made to provide a vehicle power cables retaining structure which can provide an effective use  
15 of a space above the floor by laying out power cables along an underside of the floor and which can provide good workability and productivity even when the power cables are laid out along a complex route.

[0006]

20 [Means for Solving the Problem]

With a view to solving the problem, according to a first aspect of the invention, there is provided a vehicle power cables retaining structure for retaining power cables (for example, high-tension cables 7, 7U, 7V, 7W in the embodiment that will  
25 be described later on) laid out along an underside of a floor

(for example, a floor 14 in an embodiment that will be described later on) of an electric vehicle (for example, a hybrid vehicle 1 in the embodiment that will be described later on), wherein the power cables are individually passed through metallic protection pipes (for example, protection cables 30 in the embodiment that will be described later on), and the metallic protection pipes are then retained on the underside of the floor of the vehicle.

According to the construction, the power cables can be simply laid out along the underside of the floor of the vehicle. In addition, the protection pipes protect the power cables against jumping pebbles and splashed water. Furthermore, since the protection pipes have the rigidity, the protection pipes prevent the deflection of the power cables. The protection pipes cut off the conduction of heat from the outside so as to protect the power cables against a damage that would be caused by heat. Since the protection pipes have an electromagnetic shielding function, non-shielding cables can be used as the power cables.

[0007]

According to a second aspect of the invention, there is provided a vehicle power cables retaining structure for retaining power cables (for example, 7, 7U, 7V, 7W in an embodiment that will be described later) laid out along an underside of a floor (for example, a floor 14 in the embodiment



that will be described later on) of a hybrid vehicle (for example, a hybrid vehicle 1 in the embodiment that will be described later on) which is driven to run by an engine (for example, an engine 2 in the embodiment that will be described later on) and a motor (for example, a motor/generator 3 in the embodiment that will be described later on), wherein the power cables connect a power converter (for example, an inverter 6 in the embodiment that will be described later on) disposed outside an engine compartment (for example, an engine compartment 11 that will be described later on) with the motor disposed inside the engine compartment, wherein the power cables are individually passed through metallic protection pipes (for example, protection pipes 30 in the embodiment that will be described later on) under the floor, and the metallic protection pipes are then supported from the underside of the floor, and wherein, in the engine compartment, the power cables are passed through a flexible protection tube (for example, a protection tube 20 in the embodiment that will be described later on).

[0008]

According to the construction, the power cables can be simply laid out along the underside of the floor of the hybrid vehicle. In addition, the protection pipes protect the power cables against jumping pebbles and splashed water. Furthermore, since the protection pipes have the rigidity, the protection pipes prevent the deflection of the power cables. The

protection pipes cut off the conduction of heat from the outside  
so as to protect the power cables against a damage that would  
be caused by heat. Since the protection pipes have an  
electromagnetic shielding function, non-shielding cables can  
5 be used as the power cables.

On the other hand, since the portions of the power cables  
that are connected to the motor are passed through the flexible  
protection tube in the engine compartment, the connecting job  
of the power cables with the motor can be facilitated, and the  
10 vibration of the engine can be absorbed.

[0009]

According to a third aspect of the invention, there is  
provided a vehicle power cables retaining structure as set forth  
in the second aspect of the invention, wherein the protection  
15 tube includes an iron corrugated tube or an iron flexible tube  
having a net-like shield portion.

According to the construction, an electromagnetic  
shielding function can be imparted to the protection tube, and  
non-shielding cables can be used as the power cables.

20 [0010]

According to a fourth aspect of the invention, there is  
provided a vehicle power cables retaining structure as set forth  
in the first or second aspect of the invention, wherein the  
protection pipe is formed by being bent after the power cable  
25 is passed therethrough.

According to the construction, the power cables and the protection pipes can be formed simultaneously into a configuration that follows a route along which the power cables are laid out. In addition, since the power cable is passed  
5 through the protection pipe before the protection pipe is bent, the laying-out job of the power cables can be facilitated.  
[0011]

According to a fifth aspect of the invention, there is provided a vehicle power cables retaining structure as set forth  
10 in the first or second aspect of the invention, wherein the protection pipe is decreased in diameter by crimping an intermediate portion of the protection pipe along the length thereof.

According to the construction, the power cable can easily  
15 be disposed substantially on a central axis of the protection pipe.  
[0012]

According to a sixth aspect of the invention, there is provided a vehicle power cables retaining structure as set forth  
20 in the first or second aspect of the invention, wherein the protection pipe is divided into a plurality of protection pipes, the plurality of protection pipes so divided being connected to each other by an iron corrugated tube (for example, a corrugated tube 33 in the embodiment that will be described  
25 later on) or an iron flexible tube having a net-like shield.

According to the construction, a dimensional tolerance can be absorbed by the iron flexible tube by which the protection pipes are connected to each other.

[0013]

5           According to a seventh aspect of the invention, there is provided a vehicle power cables retaining structure as set forth in any of the first to sixth aspect of the invention, wherein a refrigerant (for example, a cooling air in the embodiment that will be described later on) is allowed to flow  
10 through a gap (for example, a gap 32 in the embodiment that will be described later on) formed between the protection pipe and the power cable.

According to the construction, the power cables can be cooled, and the protection pipes can also be cooled.

15 [0014]

According to an eighth aspect of the invention, there is provided a vehicle power cables retaining structure as set forth in the seventh aspect of the invention, wherein a fin (for example, a fin 34, 35, 36 in the embodiment that will be  
20 described later on) is provided on at least either of an inner surface or an outer surface of the protection pipe in such a manner as to protrude therefrom.

According to the construction, in the event that the fin is provided on the inner surface of the protection pipe, the  
25 contact surface with the refrigerant is increased, and the

cooling effect on the protection pipe is increased. On the other hand, in the event that the fin is provided on the outer surface of the protection pipe, the contact area with air flowing the outside of the protection pipe is increased, and the cooling effect on the protection pipe is increased. In either of the cases, the high-tension cables 7 are made difficult to be subjected to heat from the outside. In addition, the fin increases the rigidity of the protection pipe.

[0015]

According to a ninth aspect of the invention, there is provided a vehicle power cables retaining structure as set forth in the eighth aspect of the invention, wherein the fin has a T-shaped cross section.

According to the construction, the surface area of the fin can be increased.

[0016]

[Mode for Carrying out the Invention]

Referring to Figs. 1 to 11, embodiments of vehicle power cables retaining structures according to the invention will be described below.

(First Embodiment)

Firstly, referring to Figs. 1 to 7, a first embodiment of a vehicle cable powers retaining structure according to the invention will be described.

Fig. 1 is a vision through side view showing a layout

of a main construction of a parallel-type hybrid vehicle 1 provided with the vehicle power cables retaining structure, and Fig. 2 is a perspective view of the power cables retaining structure.

5 [0017]

In this hybrid vehicle 1, an engine 2 and a motor/generator 3, which are sources of power, and an automatic transmission 4 are connected directly in series. The motor/generator 3 is a three-phase DC brushless motor, and the traction of the engine 2 and the motor/generator 3 is transmitted to front wheels 5, which are driving wheels, via the automatic transmission 4. In addition, in decelerating the hybrid vehicle 1, when the traction is transmitted from the front wheels 5, which are the driving wheels, to the motor/generator 3, the motor/generator 15 3 functions as a generator so as to generate a so-called regenerative braking force and recovers kinetic energy as electric energy. The recovered electric energy is stored in a high-tension battery (not shown) via an inverter (a power converter) 6.

20 [0018]

The engine 2 and the motor/generator 3 are accommodated in an engine compartment 11 ahead of a passenger compartment 10, and in this embodiment, the inverter 6 is disposed under a first seat 13A which constitutes a driver's seat or a 25 front-passenger seat, and the motor/generator 3 and the inverter

6 are connected by three-phase high-tension cables (power cables) 7U, 7V, 7W. Hereinafter, in a case where phases do not have to be distinguished specifically, the three-phase high-tension cables are generally referred to as "high-tension cables 7".

The high-tension cables 7 connected to the motor/generator 3 pass through an underside of a floor 14 from the engine compartment 11 and rises below the inverter 6 so as to be connected to the inverter 6.

[0019]

In this embodiment, as shown in Fig. 3, the high-tension cable 7 is made up of a so-called non-shielding cable formed by covering a conductor 7a with an insulating material.

In the engine compartment 11, the three-phase high-tension cables 7U, 7V, 7W are passed through a single flexible iron corrugated tube (a protection tube) 20 all together over a predetermined distance from the engine 2, and the high-tension cables 7U, 7V, 7W in the respective phases are individually passed through metallic (for example, aluminum) protection pipes 30 beyond a distal end of the corrugated tube and on the underside of the floor 14.

[0020]

An inside diameter of the protection pipe 30 is set such that a gap of a predetermined dimension is produced between the high-tension cable 7 and the protection pipe 30 when the

high-tension cable 7 is passed through the protection pipe 30,  
and the protection cable 30 is formed by being bent to a  
configuration of a route along which the high-tension cable  
7 is to be laid out after the high-tension cable 7 is passed  
5 through the protection pipe 30 in advance. In addition, after  
the high-tension cable 7 is passed through the protection pipe  
30 in advance, the protection pipe 30 is crimped to be decreased  
in diameter at a predetermined location thereof which is located  
at an intermediate position along the length of the route along  
10 which the high-tension cable 7 is laid out, as shown in Fig.  
4, and an inner circumferential surface of the protection pipe  
30 closely contact an outer circumferential surface of the  
high-tension cable 7 at the crimped portion 31, whereby the  
high-tension cable 7 is allowed to be disposed substantially  
15 on a central axis of the protection pipe 30, thereby making  
it possible to form a gap 32 around the high-tension cable 7  
circumferentially equally.

Thus, since the protection pipe 30 is formed and worked,  
that is, bent and crimped after the protection pipe 30 is passed  
20 through the protection pipe 30, the workability can be improved  
markedly when compared with a case where the high-tension cable  
7 is passed through the protection pipe 30 after the protection  
pipe 30 is bent and the like. In addition, since the high-tension  
cable 7 and the protection pipe 30 can be simultaneously formed  
25 into a configuration which follows a route along which the



high-tension cable 7 has to be laid out, the productivity can be enhanced to an extremely high level.

[0021]

As shown in Fig. 3, the protection pipe 30 through which  
5 the high-tension cable 7 is already passed is laid out along the underside of the floor and is then supported on the floor 14 via a resin clip 40.

To describe in detail, a bolt engagement hole 41 having a plurality of locking claws 44 on an inner circumferential  
10 surface thereof is provided at each end of the clip 40, and three recessed fitting portions 42 into which the protection pipe 30 can fit are provided so as to be aligned in parallel between both the bolt engagement holes 41, 41. The recessed fitting portion 42 is made to open at a top thereof, and locking  
15 claws 43 are provided on both sides of the opening in such a manner as to approach each other as they extend inwardly.

[0022]

The protection pipe 30 is forced into each fitting recessed portion 42 from the open side thereof while press compressing  
20 the locking claws 43. When a lower semi-circular portion of the protection pipe 30 reaches to lower ends of the locking claws 43, since the locking claws 43 attempt to return to their initial configuration by virtue of resiliency, the protection pipe 30 is then pushed into a bottom portion of the recessed  
25 fitting portion 42 by virtue of the resiliency of the locking

claws 43. When the protection pipe 30 hits the bottom portion of the recessed fitting portion 42, the protection pipe 30 is firmly held by the bottom portion of the recessed fitting portion 42 and the locking claws 43, whereby the removal from the recessed fitting portion 42 is prevented.

[0023]

After three protection pipes 30 are fitted into the clip as is described above, when the clip 40 is forced on a pair of stud bolts 15, 15 which are fixed downwardly through the floor 14 in advance while attempting to fit the bolt engagement holes 41, 41 in the clip 40 on the stud bolts 15, 15 so fixed, the locking claws 44 in the bolt engagement holes 41 are brought into engagement with threads on the stud bolts 15, whereby the clip 40 is fixed onto the floor 14, whereby the high-tension cable 7 is laid out along the underside of the floor 14.

Note that the clip 40 may be mounted at the crimped portion 31 of the protection pipe 30, and as this occurs, the positioning of the clip 40 can be facilitated.

[0024]

As shown in Fig. 5, an end portion of the protection pipe 30 which faces the inverter 6 is fixed to a plate-like bracket 16.

To describe in detail, an oval through hole 14a is opened in the floor 14 at a position below the inverter 6 for allowing the high-tension cables 7U, 7V, 7W to pass therethrough, and

furthermore, the plate-like bracket 16 is fixed to the floor 14 with bolts 17a and nuts 17b so as to close the through hole 14a. Three through holes 16a are formed in the bracket 16 in such a manner as to be aligned in parallel, and the end portion  
5 of the protection pipe 30 through which the high-tension cable 7 is already passed is inserted into each through hole 16a one by one, and the end portion of each protection pipe 30 is crimped to be fixed to the bracket 16 in such a manner as to hold an inner circumferential edge of the through hole 16a in the bracket  
10 16 from both sides in an axial direction. In addition, a grommet 18 is held between the bracket 16 and the floor 14, and the high-tension cables 7U, 7V, 7W which protrude from the end portions of the protection cables 30 are passed through in a sealed fashion three through holes 18 formed in the grommet  
15 18, respectively.

[0025]

The end portions of the protection pipes 30 are fixed to the floor 14 as will be described below. Firstly, the respective end portions of the three protection pipes 30 through  
20 which the high-tension cables 7U, 7V, 7W are passed, respectively, are inserted into the through holes 16a in the bracket, respectively, and the end portions are crimped to be fixed to the inner circumferential edges of the respective through holes 16a. Next, the high-tension cables 7U, 7V, 7W which protrude  
25 from the end portions of the respective protection pipes 30

are passed through the through holes 18a in the grommet 18, respectively, so that the grommet 18 is allowed to hit the bracket 16 and the end portions of the protection pipes 30. Next, the high-tension cables 7U, 7V, 7W and tube portions 18b of the grommet 18 are inserted into the through holes 14a in the floor 14 from the bottom side of the floor 14 to produce a state in which a circumferential edge portion of the grommet 18 is held by the floor 14 and the bracket 16, and the bracket 16 is then fixed with the bolts 17a and the nuts 17b.

Thus, after the protection pipes 30 through which the high-tension cables 7U, 7V, 7W are passed are fixed to the floor 14, the high-tension cables 7U, 7V, 7W which protrude from the protection pipes 30 are connected to the inverter 6.

[0026]

In addition, the other ends of the protection pipes 30 through which the high-tension cables 7 are passed are caused to rise into the engine compartment 11, and as shown in Fig. 2, end portions of the protection pipes 30 are crimped and fixed together by a cap 21. Then, the high-tension cables 7U, 7V, 7W which are exposed from the cap 21 are passed through the corrugated tube 20, and one end portion of the corrugated tube 20 is crimped into the cap 21, whereas the other end portion of the corrugated tube 20 is crimped and fixed to a terminal box (not shown) of the motor/generator 3, whereby the high-tension cables 7U, 7V, 7W are connected to the

motor/generator 3 within the terminal box.

[0027]

According to the vehicle power cables retaining structure of the first embodiment, the high-tension cables 7 can be simply  
5 laid out on the underside of the floor 14 of the hybrid vehicle 1, whereby the working efficiency in laying out the high-tension cables 7 is improved and hence the productivity is improved.

In addition, the protection pipe 30 protects the high-tension cable 7 against jumping pebbles and splashed water.  
10 Furthermore, the protection pipe having the rigidity prevents the deflection of the high-tension cable 7 that would occur due to its gravity and vibrations. In addition, the protection pipe cuts off the conduction of heat from the outside so as to protect the high-tension cable 7 against a damage that would  
15 be caused by heat.

Furthermore, since the protection tube 20 and the protection pipe have an electromagnetic shielding function, a non-shielding cable can be adopted for the high-tension cable 7, and as a result, the high-tension cable 7 can be made smaller  
20 in diameter and lighter in weight, thereby making it possible to make the protection tube 20 and the protection pipe 30 smaller in diameter and lighter in weight.

[0028]

Note that while, in this embodiment, the non-shielding  
25 cable is adopted as the high-tension cable 7, a shielding cable

can be used as the high-tension cable 7, the shielding cable including, as shown in Fig. 6, a conductor 7a, an insulating material 7b, an electromagnetic shielding wire 7c and an insulating material 7d. In this case, since the protection  
5 pipe 30 also has the electromagnetic shielding function, the noise preventing performance is enhanced.

[0029]

In addition, since the connecting portions of the high-tension cables 7 to the motor/generator 3 are accommodated  
10 in the flexible corrugated tube 20, vibrations of the engine 2 can be absorbed by the corrugated tube 20 so as to eliminate a risk that the vibrations of the engine 2 are transmitted to the protection pipes 30 and hence to the inverter 6. Additionally, the tolerance in dimension in laying out the  
15 high-tension cables 7 can also be absorbed by the corrugated tube 20, the laying-out job is facilitated and hence the productivity is enhanced.

Note that even when an iron flexible tube having a net-like shielding portion is used for the corrugated tube 20, similar  
20 function and advantage to those provided when the corrugated tube 20 is used can be provided.

[0030]

In addition, since the high-tension cable 7 can be disposed substantially on the axial center of the protection pipe 30  
25 by providing the crimped portions 31 at several intermediate

locations along the length of the protection pipe 30, the contact area between the high-tension cable 7 and the protection pipe 30 can be decreased markedly, thereby making it possible to prevent the high-tension cable 7 being damaged from the friction with the protection pipe 30. In addition, since the gap 32 is formed circumferentially equally between the high-tension cable 7 and the protection pipe 30, air residing within the gap 32 functions as a heat insulating layer, whereby the high-tension cable 7 is made difficult to be subjected to a damage caused by heat from the outside.

[0031]

Note that while, in the embodiment, the protection pipes 30 through which the high-tension cables 7U, 7V, 7W in the respective phases are constructed as a single individual pipe, respectively, the protection pipes 30 through which the high-tension pipes 7U, 7V, 7W in the respective phases are passed maybe each divided into a plurality of pipes, and the protection pipes 30 so divided may be connected to each other by an iron corrugated tube 33, as shown in Fig. 7. According to this construction, since the tolerance in dimension in laying out the high-tension cable 7 can be absorbed by the corrugated tube 33, the laying-out work can be facilitated further.

Note that even when the iron flexible tube having a net-like shielding portion is used for the corrugated tube 33, similar function and advantage to those provided when the corrugated

tube 33 is used can be provided.

[0032]

(Second Embodiment)

Next, a second embodiment of a vehicle power cables  
5 retaining structure according to the invention will be described.  
The vehicle power cables retaining structure according to the  
second embodiment differs from that according to the first  
embodiment only in that the gap 32 formed between the protection  
pipe 30 and the high-tension cable 7 is used as a cooling  
10 passageway so that cooling air (a refrigerant) is allowed to  
pass through the gap 32.

Thus, when cooling air is passed through the gap 32, since  
not only can the high-tension cable 7 be cooled but also the  
protection pipe 30 can be cooled, a heat damage caused from  
15 the outside can be prevented in an ensured fashion. In addition,  
the high-tension cable 7 can be maintained at a predetermined  
temperature or lower by adjusting the flow rate and temperature  
of the cooling air.

[0033]

20 In addition, in a case where the gap 32 is used as the  
cooling passageway, since the cooling passageway is closed in  
the event that the protection pipe 30 is crimped completely  
therearound when forming the crimped portions 31 on the  
protection pipe 30, for example, as shown in Fig. 8, the  
25 protection pipe 30 is crimped circumferentially at certain



intervals so as to be crimped only at a plurality of locations, so that gaps 32 produced on axial sides of each crimped portion can open a communication, respectively. In this case, in order to disposed the high-tension cable 7 on the axial center of the protection pipe 30, it is preferable to crimp the protection pipe 30 at three or more circumferential locations.

[0034]

Modified examples of protection pipes 30 when using the gap 32 as the cooling passageway are shown in Figs. 9 to 11.

An embodiment shown in Fig. 9 is an example where fins 34 are provided on an outer circumferential surface of a protection pipe 30 in such a manner as to protrude therefrom radially outwardly. When the fins 34 are provided on the outer circumferential surface of the protection pipe 30, the contact area with air or atmosphere flowing outside the protection pipe 30 is increased, a larger cooling effect can be provided on the protection pipe 30 by the atmosphere. In addition, since the cooling air is cooled via the protection pipe 30, a larger cooling effect can also be provided on the high-tension cable 7. Furthermore, the rigidity of the protection pipe 30 can be increased.

Note that there is imposed no limitation on the configuration, dimensions and number of the fins 34 so provided.

[0035]

An embodiment shown in Fig. 10 is an example where fins

35 are provided on an inner circumferential surface of a protection pipe 30 in such a manner as to protrude therefrom radially inwardly. When the fins 35 are provided on the inner circumferential surface of the protection pipe 30, the contact area with air flowing through a gap 32 is increased, whereby a larger cooling effect can be provided on the high-tension cable 7 by the cooling air. Consequently, the high-tension cable 7 is made difficult to be subjected to a heat damage from the outside.

In particular, since the fins 35 in the embodiment shown in Fig. 10 are each formed so as to have a substantially T-shape which allows for a larger surface area, the cooling effect onto the protection pipe becomes extremely large. However, the configuration of the fin 35 is not limited to the T-shape but a variety of configurations may be adopted. In addition, the dimensions and number of fins 35 provided are not limited in any way.

In addition, the fins 35 increases the rigidity of the protection pipe 30.

[0036]

An embodiment shown in Fig. 11 is an example where fins 36, 37 are provided both inner and outer surfaces of a protection pipe 30 in such a manner as to protrude therefrom. When the finds 36, 37 are provided on the inner circumferential surface and the outer circumference surface of the protection pipe 30,

the contact areas with air flowing inside the protection pipe 30 (namely, through a gap 32) and the atmosphere flowing outside the protection pipe 30 are increased, whereby the cooling effect on the protection pipe 30 both by the cooling air and the atmosphere is increased. In addition, since the cooling air is cooled via the protection pipe 30, the cooling effect on the high-tension cable 7 is also increased. Additionally, the fins 36, 37 increase the rigidity of the protection pipe 30.

Note that there is no limitation imposed on the configuration, dimensions and number of the fins 36, 37 so provided.

[0037]

(Other Embodiments)

Note that the invention is not limited to the embodiments that are described heretofore.

For example, while, in the embodiments, the inverter 6 is placed below the first seat 13, the inverter 6 may be placed below a second seat 13B or a third seat 13C, as shown by double-dashed lines in Fig. 1. Alternatively, the inverter 6 may be placed on the underside of the floor 14.

In addition, the power cables may be low-tension cables, and the vehicle power cables retaining structures according to the invention can be applied to a retaining structure for low-tension cables for connecting a DC/DC converter (a power converter) with a low-voltage battery (for example, a

12V-battery).

Furthermore, the invention can be applied not only to the hybrid vehicle but also an electric vehicle having only a motor as a power source.

5 [0038]

[Advantages of the Invention]

As is described heretofore, according to the first aspect of the invention, there is provided a superior advantage that the power cables can be simply laid out on the underside of the floor of the vehicle and hence, the workability and  
10 productivity can be improved.

In addition, there is also provided a superior advantage that the protection pipes protects the power cables against jumping pebbles, splashed water and heat damages from the outside  
15 and prevents the deflection of the power cables. In addition, there is provided an advantage that non-shielding cables can be adopted as the power cables, and as a result, the power cables can be made smaller in diameter and lighter in weight, and hence the protection pipe can be made smaller in diameter and lighter  
20 in weight.

[0039]

According to the second aspect of the invention, there is provided a superior advantage that the power cables can be simply laid out on the underside of the floor of the hybrid  
25 vehicle and hence the workability and productivity can be

improved.

In addition, there is also provided an advantage that under the floor, the protection pipes protect the power cables against jumping pebbles, splashed water and heat damages from the outside and prevents the deflection of the power cables. In addition, there is provided an advantage that non-shielding cables can be adopted as the power cables, and as a result, the power cables can be made smaller in diameter and lighter in weight, and additionally, the protection pipe can be made smaller in diameter and lighter in weight.

On the other hand, since the portions of the power cables that connect to the motor in the engine compartment are passed through the flexible protection tube, vibrations such as resulting from the engine or the like can be absorbed by the protection tube, and therefore, there is caused no risk that the vibrations are transmitted to the protection pipes and hence to the inverter. In addition, since the tolerance in dimensions in laying out the power cables can be absorbed by the protection tube, the power cable laying-out job is facilitated and hence the productivity is improved.

[0040]

According to the third aspect of the invention, since the electromagnetic shielding function can be imparted to the protection tube, there is provided an advantage that non-shielding cables can be adopted as the power cables, and

as a result, the power cable can be made smaller in diameter and lighter in weight, and additionally, the protection tube can also be made smaller in diameter and lighter in weight.

According to the fourth aspect of the invention, since  
5 the power cable can be passed through the protection pipe before the protection pipe is bent and the power cable and the protection pipe can be simultaneously formed into a configuration which follows a route along which the power cable is laid out, there is provided a superior advantage that the power cable laying-out  
10 job is facilitated.

[0041]

According to the fifth aspect of the invention, since the power cable can be disposed substantially at the axial center of the protection pipe, there is provided an advantage that  
15 the contact area between the power cable and the protection pipe can be decreased markedly so that not only the power cable can be prevented from being damaged through a friction with the protection pipe but also that the power cable is made difficult to be subjected to a heat damage from the outside.

20 According to the sixth aspect of the invention, since the tolerance in dimension in laying out the power cables can be absorbed by the corrugated tube or the flexible tube which is used to connect the protection pipes each other, there is provided an advantage that the power cable laying out work is  
25 facilitated.

[0042]

According to the seventh aspect of the invention, since not only the power cables but also the protection pipes can be cooled, there is provided an advantage that a heat damage  
5 caused from the outside can be prevented in an ensured fashion, and there is also provided an advantage that the power cables can be maintained at a predetermined temperature or lower by adjusting the flow rate and temperature of the refrigerant.

According to the eighth aspect of the invention, since  
10 the surface area of the protection pipe can be increased by providing the fins, there is provided an advantage that the cooling effect on the protection pipe can be increased, whereby the power cable is made difficult to be subjected to a heat damage from the outside. In addition, since the cooling air  
15 is also cooled via the protection pipe, there is provided an advantage that the cooling effect on the power cable can be increased. Furthermore, there is provided an advantage that the rigidity of the protection pipe can be enhanced.

According to the ninth aspect of the invention, since  
20 the surface area of the fins can be increased, there is provided an advantage that the cooling effect on the protection pipe can further be enhanced.

[Brief Description of the Drawings]

[Fig. 1] A vision through side view of a parallel-type hybrid  
25 vehicle 1 provided with a vehicle power cables retaining

structure according to the invention.

[Fig. 2] A perspective view of a first embodiment of a vehicle power cables retaining structure according to the invention.

[Fig. 3] A cross-sectional view showing a state in which protection pipes are mounted in the first embodiment.

[Fig. 4] A perspective view showing crimped portions of the protection pipes in the first embodiment.

[Fig. 5] A cross-sectional view showing a state in which end portions of the protection pipes are treated according to the first embodiment.

[Fig. 6] A cross-sectional view of the protection pipe through which a shielding cable is passed.

[Fig. 7] A perspective view showing connecting portions of divided protection pipes according to the first embodiment.

[Fig. 8] A cross-sectional view of a crimped portion of a protection pipe according to a second embodiment of a vehicle power cables retaining structure of the invention.

[Fig. 9] A cross-sectional view (part 1) of a protection pipe according to the second embodiment.

[Fig. 10] A cross-sectional view (part 2) of a protection pipe according to the second embodiment.

[Fig. 11] A cross-sectional view (part 3) of a protection pipe according to the second embodiment.

[Description of Reference Numerals]

1 hybrid vehicle (vehicle)



- 2 engine
- 3 motor/generator
- 6 inverter (power converter)
- 7, 7U, 7V, 7W high-tension cable (power cable)
- 5 11 engine compartment
- 14 floor
- 20 protection tube
- 30 protection pipe
- 31 crimped portion
- 10 32 gap
- 33 corrugated tube
- 34, 35, 36, 37 fin

[Designation of Document]      Abstract

[Abstract]

[Problem]

To enable the easy layout of high-tension cables  
5 connecting an inverter with a motor/generator on an underside  
of a floor.

[Means for Resolution]

High-tension cables 7U, 7V, 7W connect an inverter 6  
disposed outside an engine compartment with a motor/generator  
10 3 disposed in the engine compartment, the high-tension cables  
7U, 7V, 7W are individually passed through metallic protection  
pipes 30 under a floor of a vehicle, the protection pipes 30  
are supported from an underside of the floor, and the  
high-tension cables 7U, 7V, 7W are passed through a protection  
15 tube 20 over a predetermined distance from the motor/generator  
3 in the engine compartment.

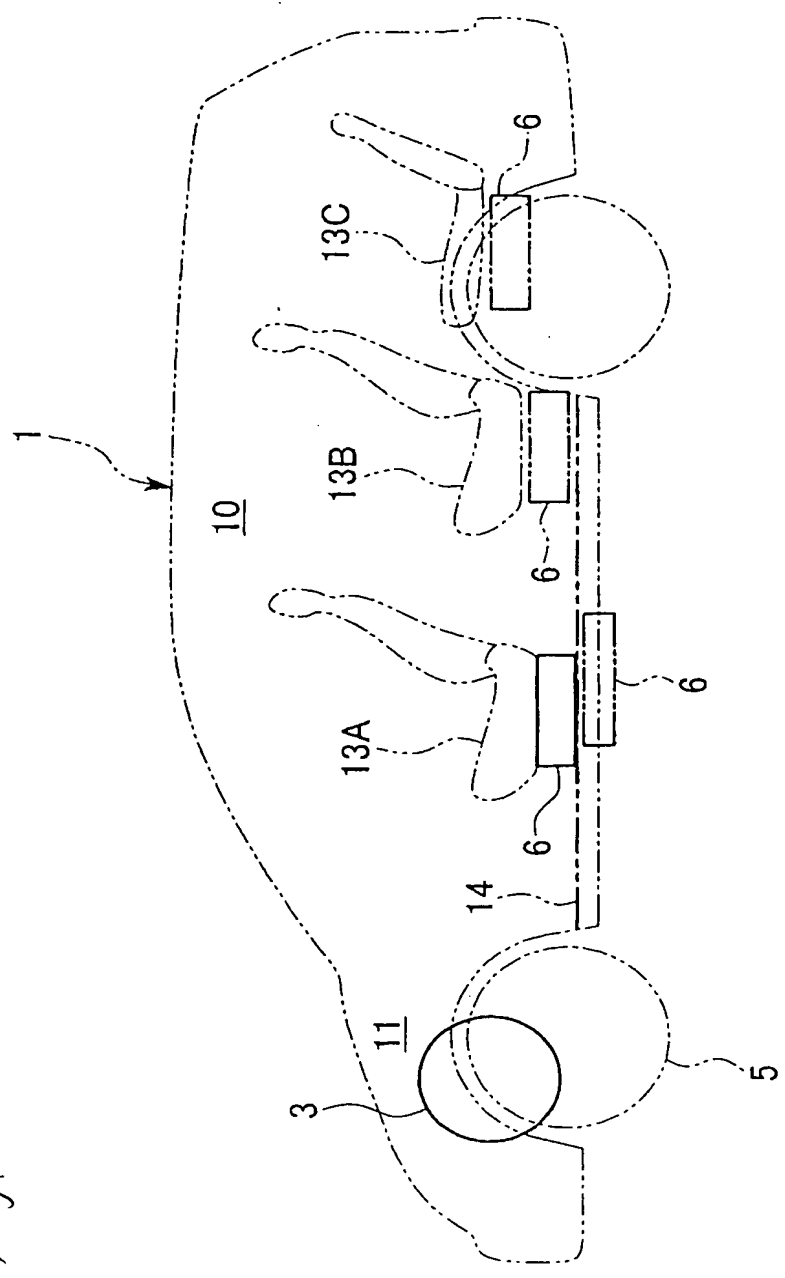
[Selected Drawing]      Fig. 2



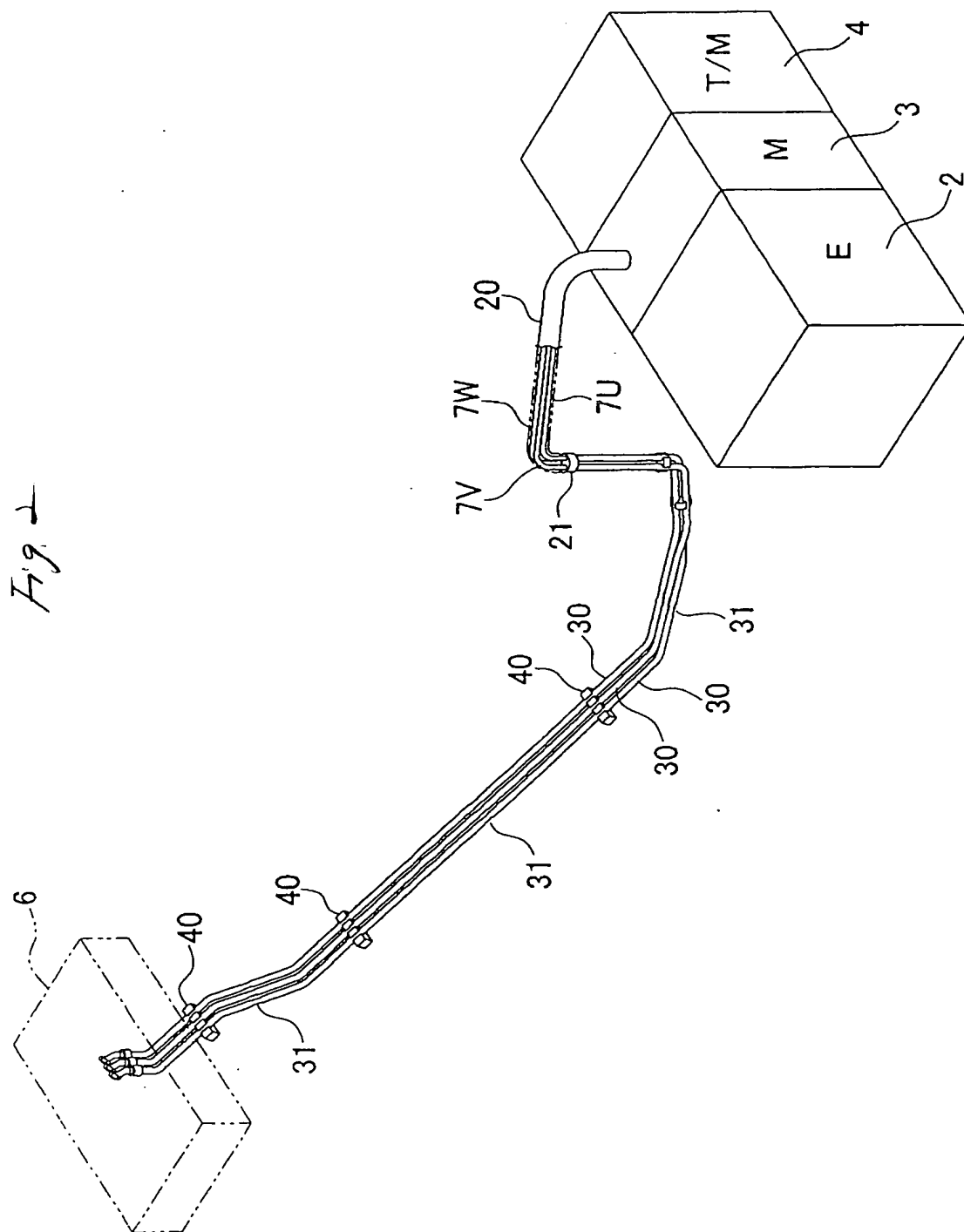
~~【書類名】 図面~~

~~【図1】~~

Fig. 1



【図 2】



〔図3〕

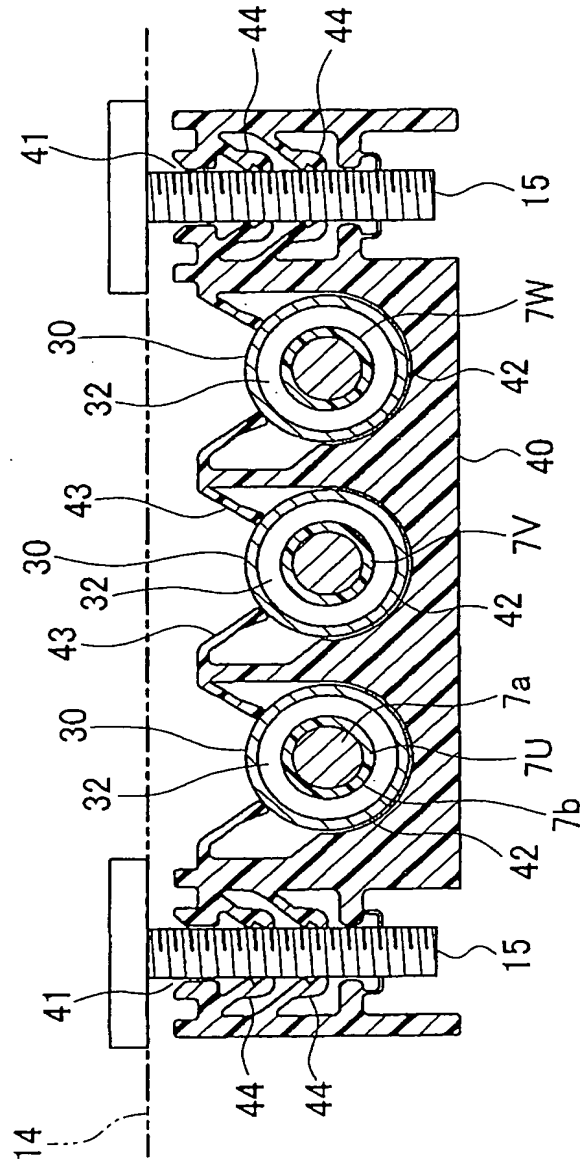


Fig. 3

~~【図4】~~

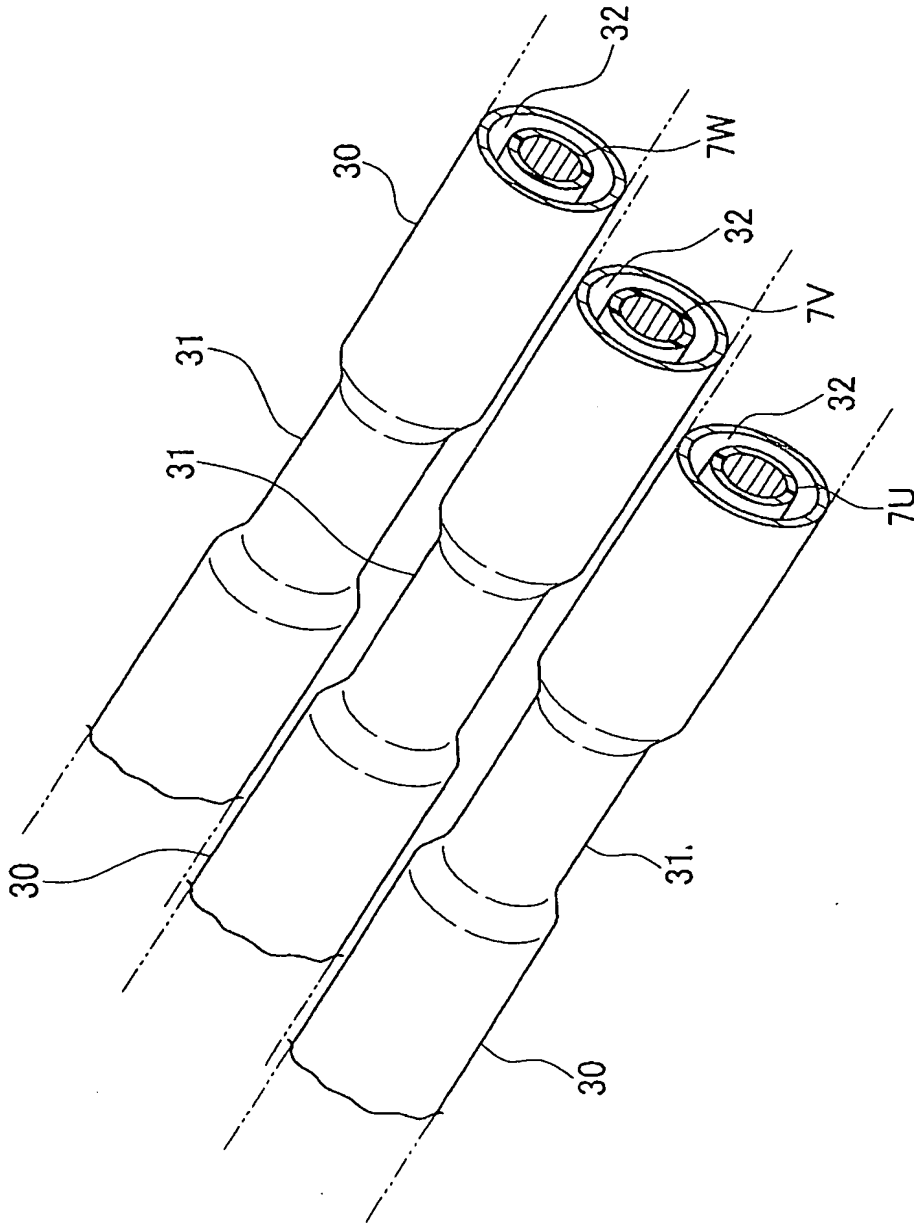


Fig. 4

【図5】

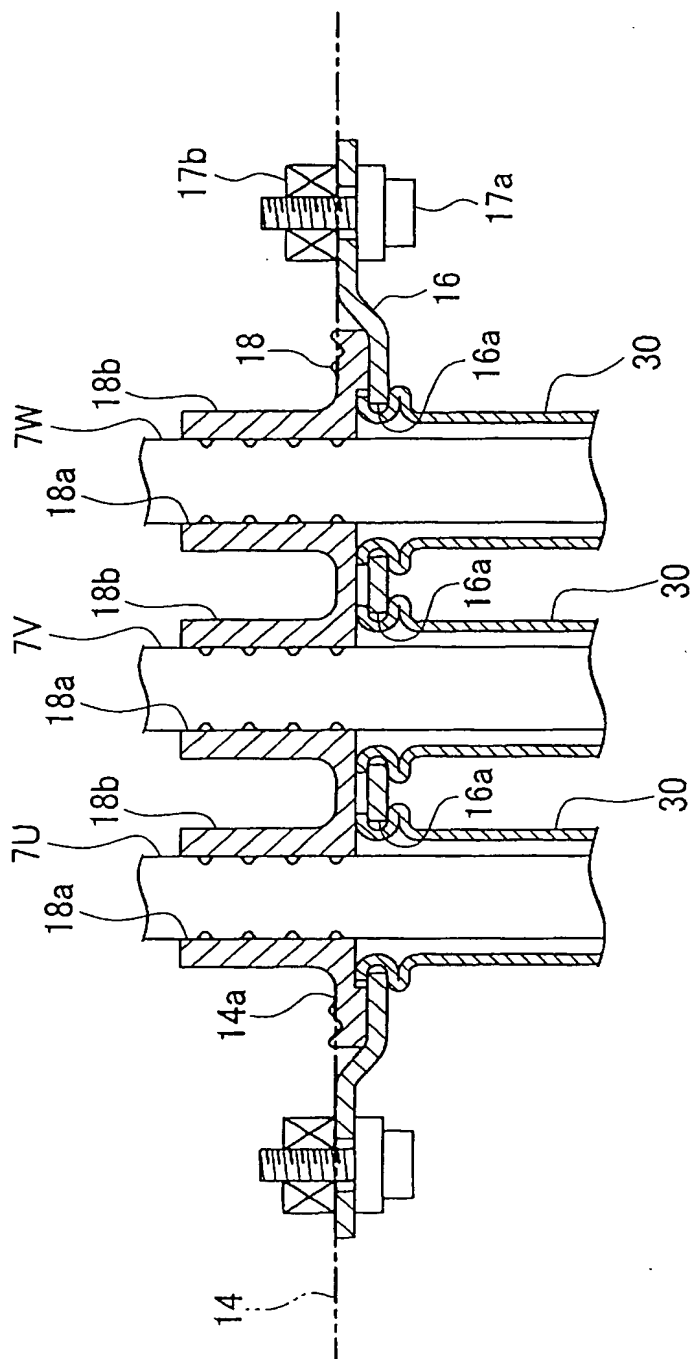
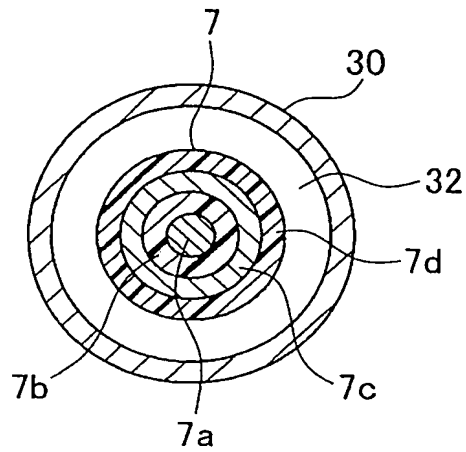


Fig. 5

~~【図6】~~

Fig. 6





〔図7〕

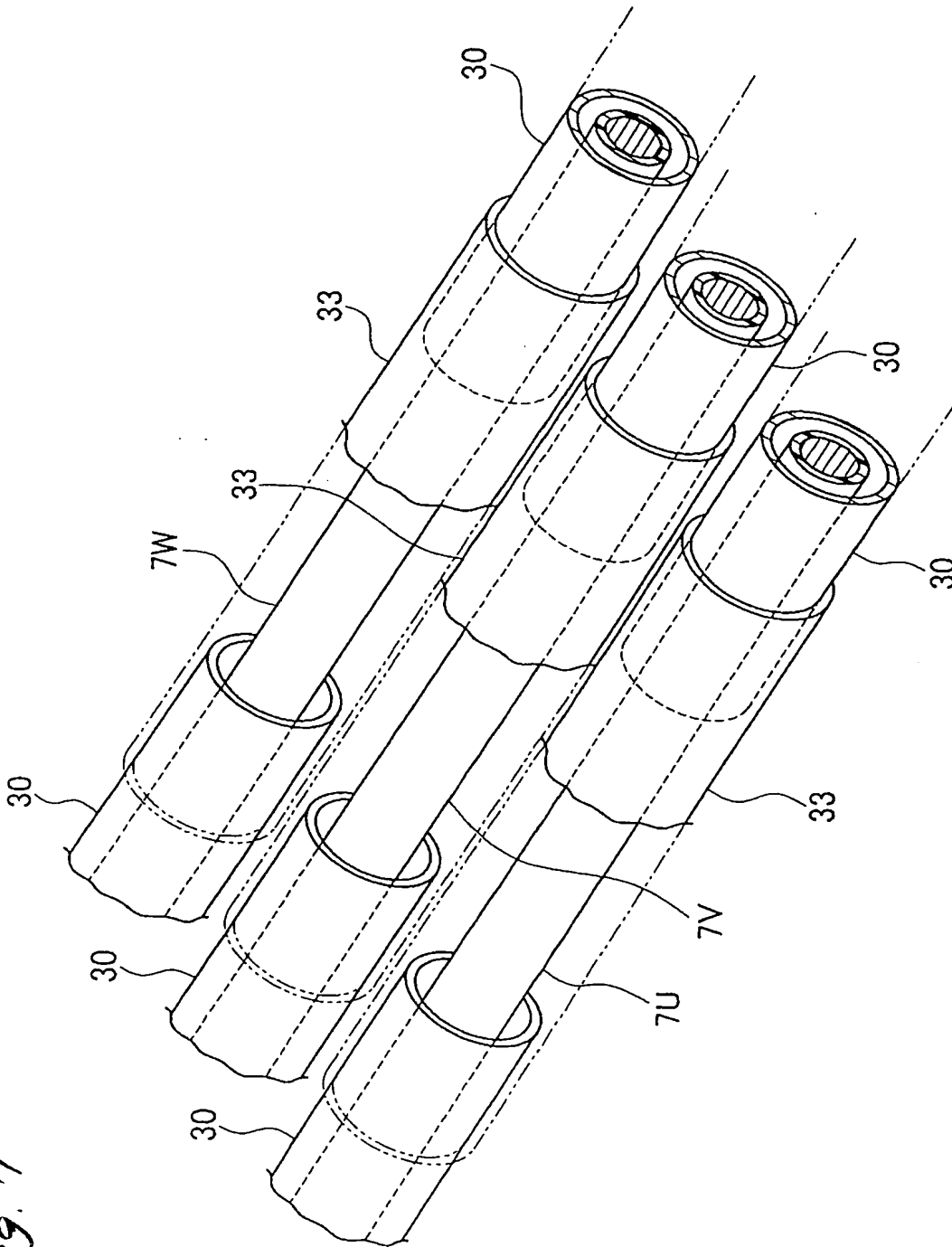
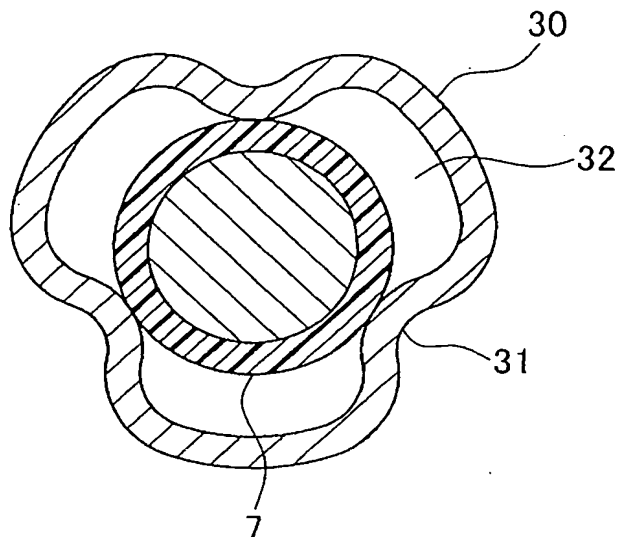


Fig. 7

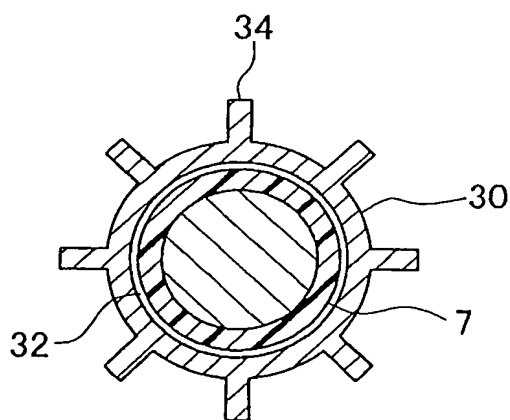
~~〔図8〕~~

Fig. 8



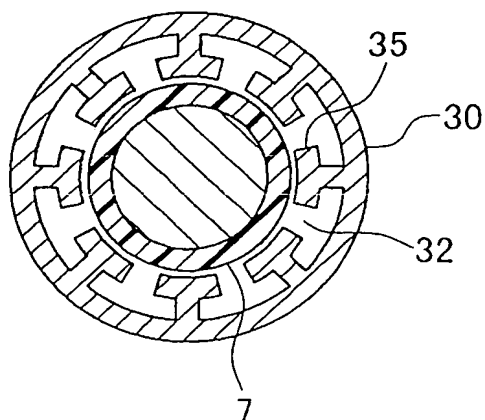
~~〔図9〕~~

Fig. 9



~~〔図10〕~~

Fig. 10



~~【図11】~~

Fig. 11

